

Jan Peter Toennies: “die Wissenschaft für ihn Kunst wird, ohne ihren Character als Wissenschaft aufzugeben”

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The great sociologist Ferdinand Toennies (Fig. 1), whose 170th birthday falls in 2025, would be very happy and proud to be here with us to celebrate the 95th birthday of his equally famous grandson. For Peter, indeed, the conception of science as a noble art form, as was the firm belief of his grandfather, then in antithesis to Nietzsche, has always been a rule of life and of his teaching. When I contemplate the Hugo helium spectrometer, I admire art in its design and in the questions to which answers are sought, in its construction, in its operation, in its results and in the new questions they pose to the theoretical interpreter.

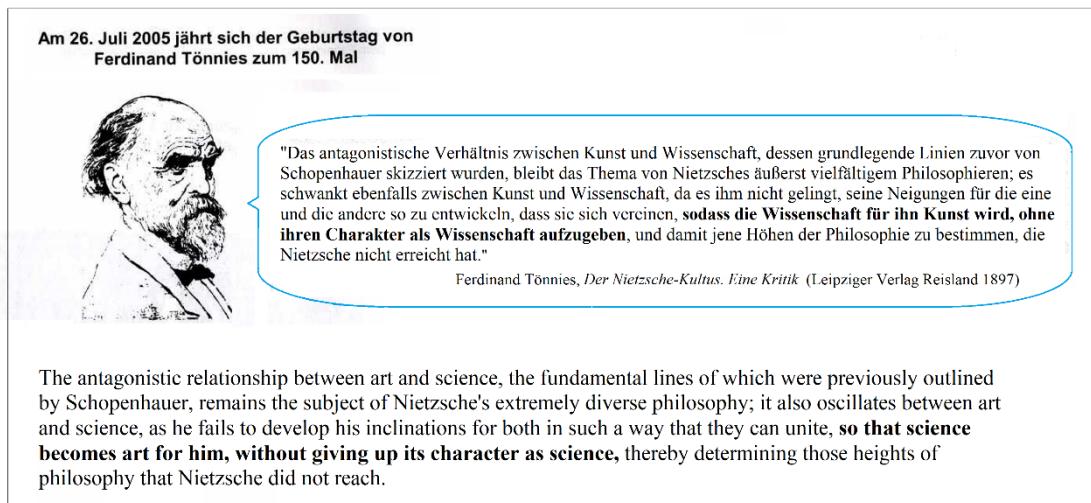


Fig. 1. The great sociologist Ferdinand Tönnies, Peter's grandfather, conceived science as a noble form or art, against Nietzsche's conceptions

I'm glad to be here with so many of his former students. In this respect, I always considered myself his student, although our first meeting 52 years ago, curiously enough, took place with roles reversed. The Enrico Fermi International School of Physics in Varenna on Lake Como (Fig. 2) was the first invitation for me, a very young professor, to give three lectures on the theory of helium scattering from surface phonons, while Peter, who had just become director at MPI-SF, was there as a student! I wanted to show that I was doing very difficult things, where surface dynamics with the Green's function method was combined with the inelastic atom scattering theory worked out by Cabrera, Celli and Manson. My lectures made the whole audience straighten their hair, including a horrified Fermi bust. “Terrible theoretician!” said Peter (Fig. 3), but a few years later, after having put together the first high-resolution He atom scattering machine, called me in Göttingen in 1980. In this way we began our beautiful and still vibrant collaboration.

Varenna 1973: Nice to meet you, Professor Toennies!

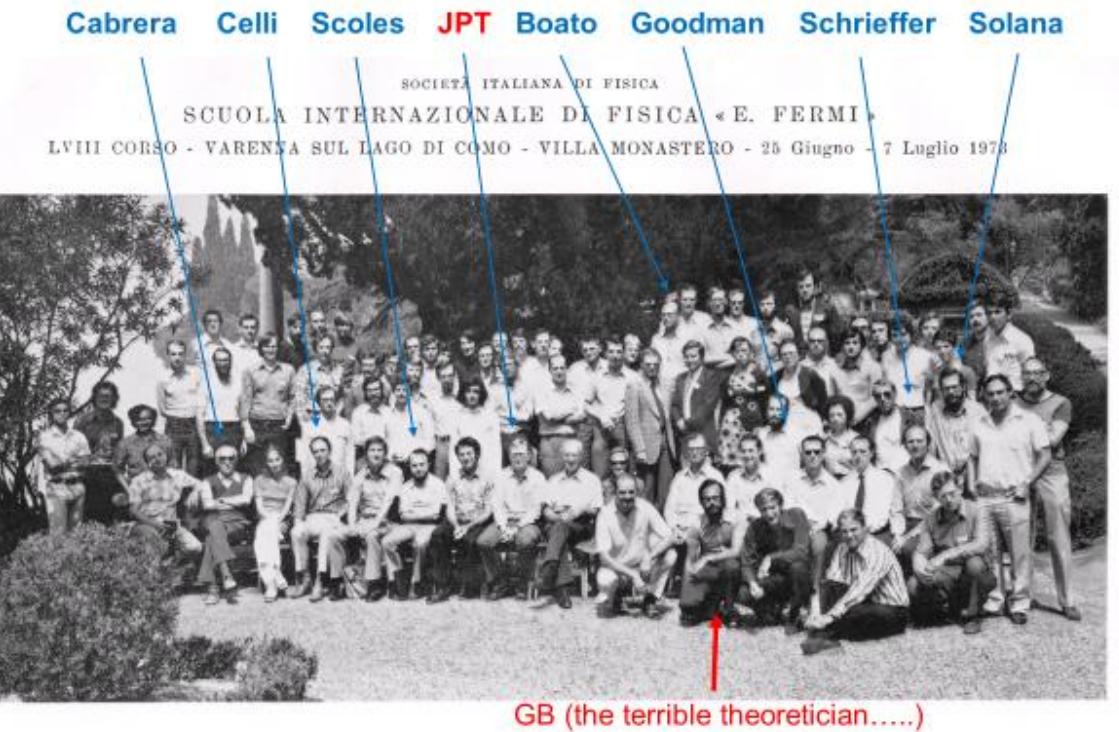


Fig. 2. The participants in the 1973 Enrico Fermi International Physics School in Varenna

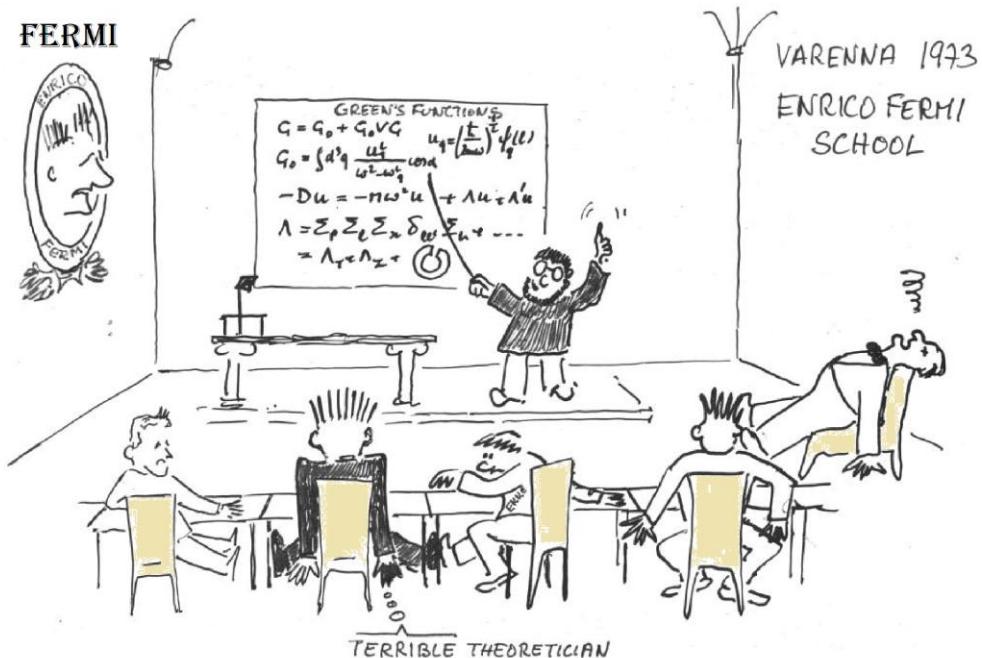


Fig. 3. Giorgio explaining his Green's function theory of surface phonons at the Enrico Fermi School in Varenna

Peter's machine was substantially outperforming in resolution those operating in Genoa (Boato and Valbusa groups), Noordwijk (Feuerbacher, Willis), Bell Labs (Mark Cardillo

(Fig. 4)), and IBM Zurich (Rieder), and competing in the measurement of surface phonon dispersion curves with EELS (Harald Ibach and George Comsa in Jülich), though in a complementary way.

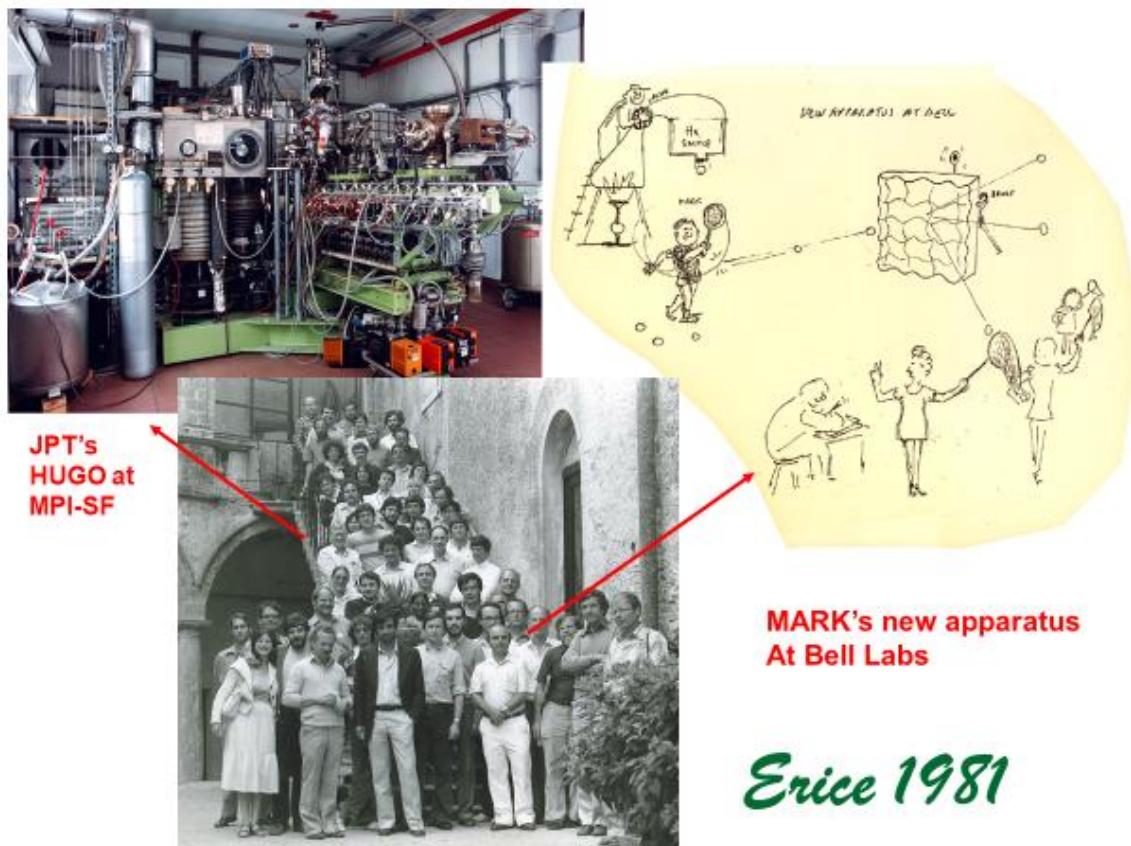


Fig. 4. Comparison between Peter's HAS apparatus HUGO at the MPI-SF in Göttingen and Mark Cardillo's apparatus at Bell Labs. Both Mark and Peter were at the Erice school in 1981. Mark was a tennis champion.



Fig. 5. From the Ettore Majorana Centre in Erice

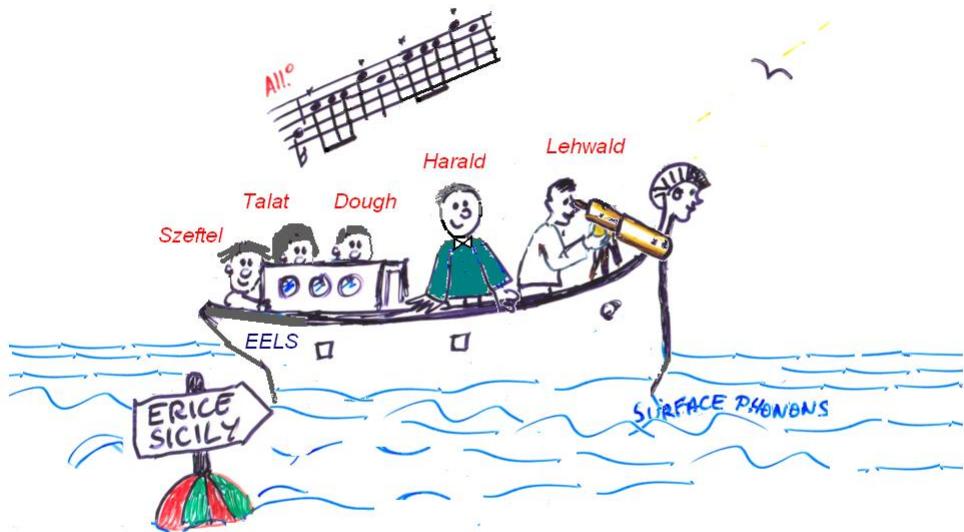


Fig. 6: Der Fliegende Holländer vs.,Die Walküre

Shortly afterwards, in 1981, Ugo Valbusa and I organised a course on the dynamics of gas-surface interaction at the Majorana Centre, in the beautiful setting of Erice, Sicily (Figs. 4,5), where we took stock of the new surface phonon spectroscopy by atom scattering. While atoms transmit energy to vibrations through surface charge density oscillations, juggling Scylla, Charybdis and supernovae, EELS electrons do not see the

surface charge density oscillations and directly observe the vibrations of the underlying atoms (Fig. 6). Two different philosophies, two different anthems: in a cartoon I imagined Peter, Guido and Bruce singing *Der Fliegende Holländer*, while Harald and his coworkers preferred *Die Walküre*. But Helium atom scattering (HAS) was indeed far reaching.

I had the good chance to attend in Göttingen the 90th birthday party of Friedrich Hund, and couldn't help but ask him a question he's been asked many times: what are his three rules for getting to his age in such good shape? The answer was immediate: do things with maximum spin; consider the stream of the most momentous ones, but go in the opposite direction! This was often Peter's philosophy: explore new territories, where no one has ventured. Examples where Peter involved me are the superfluidity of He 4 clusters, and the geyser effect in the expansion of solid helium, to the point of providing the only experimental evidence so far of the vacancy superfluidity mechanism for the supersolid state predicted in the seventies by Andreev and Lifshitz. On the cluster side a group of young Russian clusterists, like Andrey Vilesov, Vitaly Kresin (now both in Los Angeles), Oleg Kornilov (now at MBI in Berlin), *et al.*, after breathing Ginsburg-Landau atmosphere in their native land, joined Peter at the MPI-SF in a series of memorable works (Fig. 7).



Fig. 7. Bad Honnef 2011: an excursion with the Russian clusterists Vitaly, Andrey, Oleg, Slava, *et al.*

But there is another example where Peter, then with Bruce, did something that no one else had dared to do: to desecrate a temple (with no consequences) by ordering (and obtaining) an alkoholfreies Bier in the legendary Hofbräuhaus München (Fig. 8).



Fig. 8. Desecrating a temple: having an alcoholfree beer at the Hofbräuhaus München

A few years later, this progress (I mean HAS) started being internationally recognized. In 1992 Gerhard Ertl, Harald Ibach, and Peter Toennies received in Prag the EPS-CMD Prize for *pioneering studies of surface structures, dynamics and reactions through the development of novel experimental methods*.



Fig. 9. Peter and Giorgio for the 1992 the Max-Planck Prize



FOR THE THEORETICAL PHYSICIST
SUNRISE IS NOT A PHYSICAL OBSERVABLE
(H. Bethe)



Fig. 10. On the train to Bonn very early in the morning (1992).

In the same year, Peter and I received the Max Planck Prize from the German government's research minister (Fig. 9). We travelled by train from Göttingen to Bonn, leaving early in the morning. Although Hans Bethe had stated that "for the theoretical physicist the sunrise is not a physical observable", Peter again wanted to disprove Bethe's theorem, sleeping soundly on the train the whole way, while the theoretical physicist in charge contemplated the sunrise from the window (Fig. 10). Actually, when the ticket collector woke Peter up with a peremptory "Fahrkarte, bitte!" it was already 9 p.m....

Our surface dynamics community celebrated these advances and first recognitions with a workshop supported by EPS, held at the famous Alcuin College in York in 1993. In the official photograph of participants (Fig. 11) both the experimentalists Peter and Harald look very serious in York, despite having just shared the 1992 EPS-CMD Prize, while the theoreticians Dick and Giorgio (the clear and the terrible) look very happy: much has been understood, but new mysteries and puzzles are emerging from the spectrometers, paving the way to further progress.



Fig. 11. At the Alcuin College in York in 1993

A few years later, Giacinto Scoles and Peter Toennies will be awarded the 2006 Benjamin Franklin Medal in Physics. It is interesting that both Giacinto and Harald were often competing with Peter on different questions (definitely more than Peter was competing with them!), and nevertheless they shared the Franklin and the EPS-CMD Prizes, respectively! Actually, the competition was the salt which triggered the progress.



Fig. 12. Vittorio Celli, Peter and Giorgio in Göttingen explaining on the phone the new HAS electron-phonon theory to Bibi in Modena

One issue that fueled a long discussion between Harald Ibach and Peter (but also with the theoretical group in Modena led by the late Bibi Bortolani (Fig. 12) was that in conducting surfaces atoms transmit energy to phonons via electron-phonon interaction, since helium atoms are repelled by the surface charge density. For this reason, inelastic HAS provides not only information on electron-phonon interaction, but also on collective electronic excitations in the THz region, i.e. surface acoustic plasmons and hole-electron excitations.

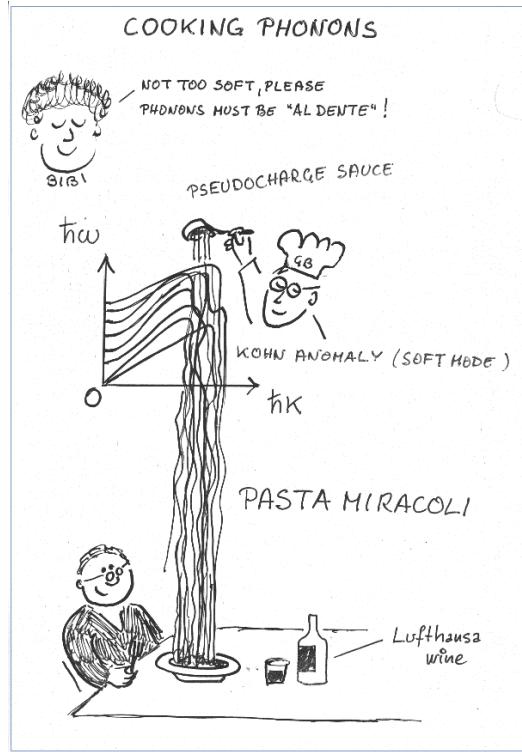


Fig. 13. Bibi recommends that the soft spaghetti modes have to be cooked “al dente”.

The last fifteen years of HAS have been marked by this progress. At the end of the story Bibi was very happy that the new electron-phonon theory of HAS could account for the giant Kohn anomalies of hydrogen-covered W(110) and Mo(110), although always recommending that the *spaghetti diagrams* should always be cooked “al dente” (Fig. 13). Not sure that Harald digested the giant Kohn anomalies “al dente” for the simple reason that their hole-electron excitation nature made them not observable by EELS. More or less like the sunrise to Peter.

The restless evolution of HAS spectroscopy frustrated the original intention to write a review article, despite the invitation and the pressure by Charly Duke, at the time Editor-in-Chief of Surface Science Report. On August 13, 1998, Peter, in a postcard from Prince Edward Island (Fig. 14), was enquiring about “any progress on the review?”

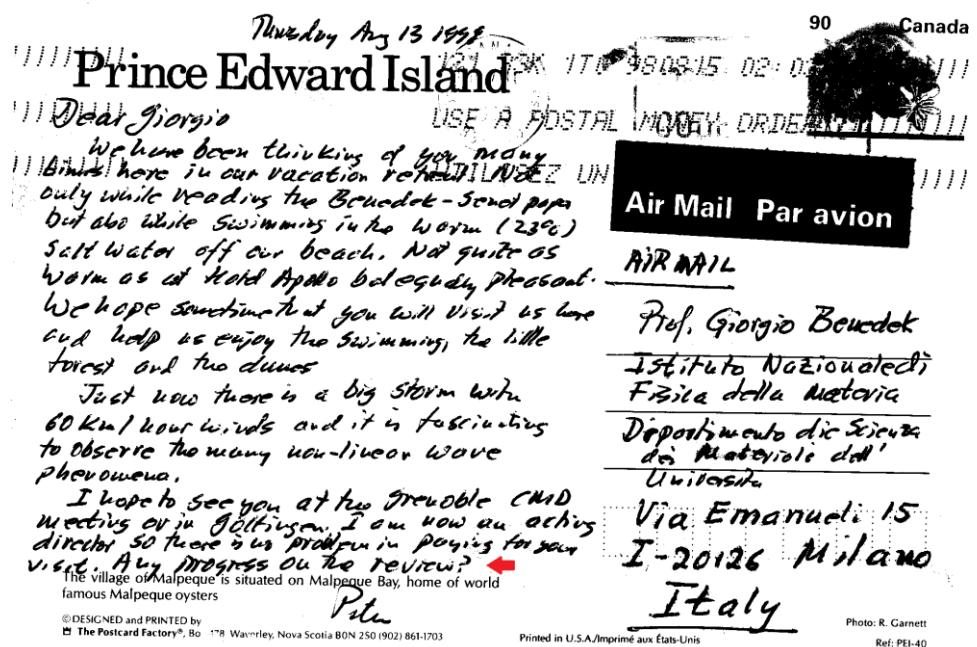


Fig. 14. Peter, enyoing August vacations at Prince Edward Island, is worrying for the “big review”

Finally, the “big review”, as it was called, became a book, slowly growing as a multilayer structure, edition by edition (Fig.15), up to the final one, the 45th, just twenty years after the review article that Peter was asking about. In 2018 the “Bible” was finally published by Springer: about 650 pages under the title “Atomic Scale Dynamics at Surfaces”! The title, invented by Angela Lahee, made us very happy (Fig. 16).

MULTILAYER STRUCTURES



Fig. 15. Actually the 45th version of the “big review” seems to be the final one and will soon transform, after 20 years, into “the HAS Bible”

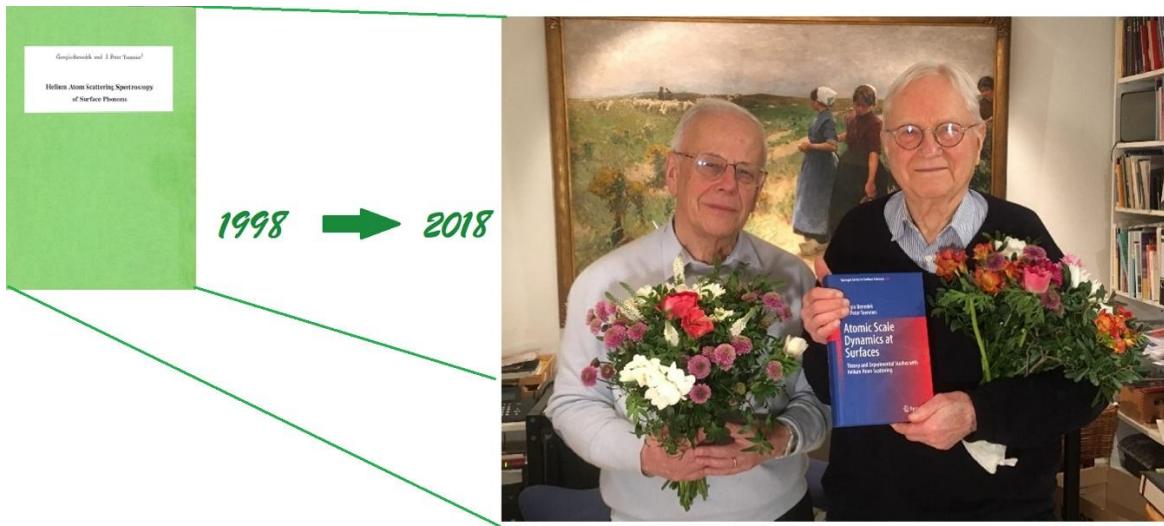


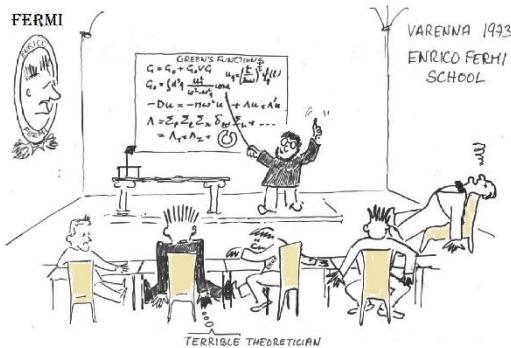
Fig. 16 “We dedicate this book to our wives Carmen and Monika. We thank them for their selfless patience, their constant support and enduring encouragement” (on page vi of the book; the dedicatees are portrayed in the background painting)



Fig. 17. Peter claims to be suspicious about the web, but dreaming a massive digitalization of all work done, so as to allow for a massive data mining in the future. Which is the case today!

It seems that after half a century of such a wonderful and productive collaboration, Enrico Fermi himself has finally appreciated the great experimentalist and forgiven the *terrible theoretician*, thus agreeing with the Italian Physical Society that the 2022 Enrico Fermi Prize be awarded to Peter and Giorgio (Fig. 18).

HAPPY
BIRTHDAY,
PETER!



It seems Fermi
has finally forgiven
the terrible theoretician....

Best Wishes
Giorgio



Taleggio on the way to Göttingen

Fig. 18. A Happy 59th Birthday, Peter!

Thank you very much, Peter, for the beautiful art of science that I, and certainly all of us here, have learnt from you, for having opened to all of us, during several years of intense collaboration, marvellous landscapes over “the best of all possible works”, for having realized your grandfather’s dream of making science an art masterpiece, a real wizardry (Fig. 19).



Fig. 19. Peter the wizard

Gravity attracts everything to the center of the globe, it is the driving force towards the most profound understanding of things. But the path is never straight, several difficulties, pitfalls, errors have to be overcome. Peter realized at home a beautiful toy, a very inspiring metaphor of this: a steel ball slowly rolls down from the attic to the ground floor along a very complicated path, where all possible accidents occur, until it switches on an electric bell, triumphantly announcing the victory at the end of the odyssey.

Last but first, a special recognition and praise for Monika, who has ensured the driving force, opposite in direction to gravity, for elevation, the driving force of all positive human endeavours, whether in science or art, or both of them together:

Das Ewig-Weibliche zieht uns inhan.

A very happy birthday, Peter!



I wish to conclude by adding, as it was a rule in the medieval academic world, a few Latin hexameters (with its English translation for those who have forgotten the ancient academic language) in the next page. You remember, Peter, when Giampaolo Brivio, in a similar occasion many years ago, addressed you and the audience in Latin. Regretfully Giampaolo, my second student and full professor at my department at the University of Milano-Bicocca, passed away prematurely, exactly five years ago, on the 25th of May 2020. Otherwise, he would have been here with us tonight, and would have presented a joyful elegy in Latin in your honour. In what follows, I hope I'm up to his level with the following few Latin hexameters:

Summo Johannis Petro Toennio dicatum

*Non modo Germanice, Petre, sed etiam Latine,
Nonaginta quinque annos tuos academico more
cum amicis celebrari decet et multis alumnis!
Mensurasti primus spectra cum helio phononum
In superficie plurium materialium magni momenti.
Cum Sinense KT studiasti vires dispersionis,
quae hodie ferunt egregie nomina vestra.
Superfluida fecisti helii aggregata atomorum,
Et supersolidi primam unicamque evidentiam
In expansione sua in vacuo invenisti oscillante.
Accipe hoc igitur, Petre, nobilis tributum
quo volumus te omnes magno cum amore honorare.
Calicibus pomi suci plenis cum gaudio bibendumst
ad majora pro scientia vitaque, et multos ad annos!*

*Georgius Benedictus composit
in Gottinga, die ante Calendas Junii, anno MMXXV*

Dedicated to the Jan Peter Toennies, the Great

Not only in German, Peter, but also in Latin,
Your ninety-five years should be celebrated
In the academic style with friends and many students!
You have been the first to measure with helium the spectra of phonons
At the surface of several materials of great interest.
With the Chinese KT you studied the forces of dispersion,
Which today bear your names with distinction.
You made helium aggregates of atoms superfluid,
And you found the first and only evidence of a super-solid
In its oscillating expansion in vacuum.
Accept, therefore, Peter, this noble tribute
with which we all want to honour you with great love.
It is time to drink with joy from cups full of apple juice and wish you
greater things in science and life, and many more years to come!

*Giorgio Benedek wrote
in Göttingen on May 31, 2025*